(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 219 987 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
03.07.2002 Bulletin 2002/27

(51) Int Cl.7: G02B 6/255

(21) Application number: 01130239.5

(22) Date of filing: 19.12.2001

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 28.12.2000 JP 2000401815

(71) Applicant: Sumitomo Electric Industries, Ltd.
Osaka-shi, Osaka 541-0041 (JP)

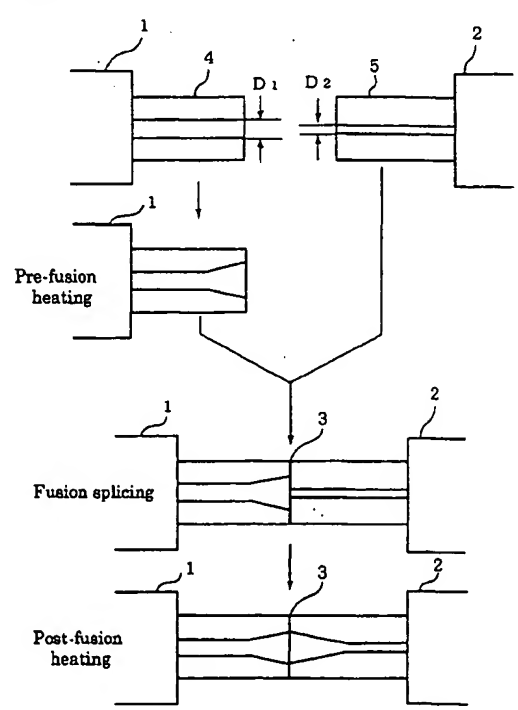
(72) Inventors:
- Kato, Takatoshi
Sakae-ku, Yokohama-shi, Kanagawa (JP)
- Kashiwada, Tomonori
Sakae-ku, Yokohama-shi, Kanagawa (JP)
- Fukuda, Keiichiro
Sakae-ku, Yokohama-shi, Kanagawa (JP)
- Iwata, Noriko
Sakae-ku, Yokohama-shi, Kanagawa (JP)

(74) Representative: HOFFMANN - EITLE
Patent- und Rechtsanwälte
Arabellastrasse 4
81925 München (DE)

(54) Optical fiber splicing method

(57) A method of splicing optical fibers having different mode field diameters (MFDs), (D1) and (D2), is provided to reduce the splicing loss. In a pre-fusion heating step, the MFD at an end face of the optical fiber (1) having larger MFD is enlarged by heating a portion including the end face thereof so as to diffuse a dopant. After the pre-fusion heating step, fusion-splicing of the first (1) and the second (2) optical fibers is performed. Thereafter, during a post-fusion heating step, the dopant is further diffused by heating a portion (3) including the fusion-spliced parts of the two optical fibers.

FIG. 1



EP 1 219 987 A1

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a method of connecting, by fusion-splicing, two optical fibers having different mode field diameter (hereinafter, referred to as MFD) from each other, and also to an optical transmission line using the two optical fibers thus spliced together.

Description of the Background Art

[0002] A dispersion-compensating fiber has been used to compensate chromatic dispersion of an optical transmission line comprising optical fibers. An optical amplifier having an optical fiber whose optical waveguide region is doped with a rare earth element has been used to compensate loss in the optical transmission line. In such cases, two optical fibers having different MFD have had to be connected together. Two connecting methods have been known, namely, a method of using a connector and fusion-splicing, the latter causing small connecting loss.

[0003] To connect two optical fibers by fusion-splicing, the coating on each optical fiber is removed at the adjacent end thereof, then the adjacent end faces of the two optical fibers are butted together, and the end faces are softened and fusion-spliced by heating with an arc discharge or the like. When the MFDs of the two fibers are equal to each other at the fusion-splicing portions, the splicing loss is small. When the MFDs are different, the larger is the difference in diameters, the larger becomes the splicing loss.

[0004] An optical fiber splicing method has been disclosed in Japanese Patent Application Laid Open No. 04-118607, which is intended to reduce the splicing loss when two optical fibers having different MFDs has been fusion-spliced. Two optical fibers are referred to as a first optical fiber having a larger MFD and a second optical fiber having a smaller MFD, respectively.

[0005] According to this splicing method, the MFD of the second optical fiber is enlarged by heating a portion including the adjacent end face thereof and by diffusing a dopant therein, and then the first and second optical fibers are fusion-spliced. Thus, the difference between the MFDs of the first and the second optical fibers can be reduced at the fusion-splicing portion, thereby leading to a reduction in the splicing loss.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide an optical fiber splicing method for reducing splicing loss of a first optical fiber and a second optical fiber whose MFDs are different from each other, and an optical transmission line comprising such fibers.

[0007] In order to achieve this object, a method of connecting optical fibers by fusion-splicing is provided in which a first optical fiber having a first MFD and a second optical fiber having a second MFD smaller than the first MFD are connected together by fusion-splicing. The method comprises a pre-fusion heating step of heating a portion including the adjacent end face of the first optical fiber so as to diffuse a dopant, and a fusion-splicing step of connecting the first and the second optical fibers.

[0008] In one embodiment, the method further comprises a post-fusion heating step of heating a portion including the fusion-spliced part between the first and the second optical fibers after the fusion-splicing step. The dopant may be diffused until the MFD $2W_1$ defined by Petermann I at the adjacent end face of the first optical fiber is enlarged by at least 1 μm during pre-fusion heating step. MFD $2W_1$ can be obtained by the following formula:

$$W_1^2 = \frac{2\int_0^\infty E^2(r)r^2 rdr}{\int_0^\infty E^2(r)rdr}$$

, where E (r) represents the distribution of the LP01 mode.

[0009] Pursuant to another aspect of the present invention, an optical transmission line is provided in which a first optical fiber having a first MFD and a second optical fiber having a second MFD smaller than the first MFD are connected together by fusion-splicing with the above-described method.

[0010] The above and further object and novel features of the invention will be more fully clarified from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustrating only and are not intended as a definition of the limits of the invention.

BRIEF DESCRIPTION OF THE DRAWING

[0011] In order to more fully understand the drawings used in the detailed description of the present invention, a brief description of each drawing is provided:

Figure 1 is an illustration of a method of splicing optical fibers according to an embodiment of the present invention;

Figure 2 is an illustration of the refractive index profile of a first optical fiber (Optical Fiber 1);

Figure 3 is an illustration of the refractive index profile of a second optical fiber (Optical Fiber 2);

Figures 4A is a graph showing variation of MFDs at the adjacent end faces of the Optical Fiber 1 and 2

and Figure 4B showing a change of splicing loss, respectively, versus heating time, with the method of splicing optical fibers according to an embodiment of the present invention;

Figure 5A is a graph showing variation of MFDs at the adjacent end faces of the Optical Fiber 1 and 2 and Figure 5B showing a change of splicing loss, respectively, versus heating time, with the method of splicing optical fibers similar to the embodiment of the present invention, but without a pre-fusion heating step; and

Figure 6 shows an optical transmission line as an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0012] In the following, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings. To facilitate the comprehension of the explanation, the same reference numerals denote the same parts, where possible, throughout the drawings, and a repeated explanation will be omitted. The dimensions in the drawings are partly exaggerated and do not always correspond to actual ratios of the dimensions.

[0013] Referring to Fig. 1, an embodiment of a method for splicing optical fibers according to the present invention will be described. At first, a first optical fiber (Optical Fiber 1) and a second optical fiber (Optical Fiber 2) are prepared. The MFD D_2 of the Optical Fiber 2 is smaller than the MFD D_1 of the Optical Fiber 1 in the range of operating wavelength, e.g., at the wavelength of 1.55 µm. Then, coatings of the Optical Fiber 1 and 2 are removed at the adjacent end thereof to be fusion spliced, and a glass 4 and a glass 5 are exposed. The pair of lines drawn inside each optical fiber in the figure indicates the MFD at each position along the longitudinal direction of each optical fiber.

[0014] Optical Fiber 1 is, e.g., a typical single mode optical fiber having zero dispersion wavelength around 1.3 µm and about 17 ps/nm/km at 1.55 µm. The MFD D_1 is about 10 µm at the wavelength of 1.55 µm. The Optical Fiber 1 has a step index profile doped with germania (GeO_2) in a region including the optical axis.

[0015] On the other hand, the Optical Fiber 2 is, e.g., a dispersion-compensating optical fiber having a chromatic dispersion value ranging from about -20 to -250 ps/nm/km at the wavelength of 1.55 µm. The MFD D_2 is in the order of several micrometers at the wavelength of 1.55 µm.

[0016] The Optical Fiber 2 has a more complicated refractive index profile than the Optical Fiber 1. The Optical Fiber 2 is doped with an appropriate amount of, for example, GeO_2 or fluorine (F) in a predetermined region thereof so as to increase or decrease, respectively, the refractive index thereof.

[0017] In the pre-fusion heating step, the MFD at the adjacent end of the Optical Fiber 1, which is larger than that of the Optical Fiber 2, is enlarged by heating a portion including the adjacent end so as to diffuse the dopant (GeO_2 and F). The MFD at the adjacent end face of the Optical Fiber 1, as defined by Petermann I, is preferably enlarged by at least 1 µm. A burner flame, an arc discharge to be generated by a pair of opposing electrodes flanking the Optical Fiber 1, and a high-power CO_2 laser beam can be used as a heating source in the pre-fusion heating step. The heating temperature in this step is determined such that the dopant contained in the Optical Fiber 1 can be diffused, but this fiber itself is not softened.

[0018] A fusion-splicing step is performed after the pre-fusion heating step. In the fusion-splicing step, the Optical Fiber 1 and 2 are connected together by fusion-splicing. More specifically, the adjacent end faces of the Optical Fiber 1 and 2 are butted together, and then the portion including the adjacent end faces is heated and softened by an arc discharge generated by a pair of opposing electrodes flanking the butted end faces, thereby fusion-splicing of the two optical fibers can be performed. In the ordinary fusion-splicing step, there is little variation in the MFD of the Optical Fiber 1, substantially keeping the diameter as enlarged in the pre-fusion heating step. There is also little variation in the MFD of the Optical Fiber 2 in this fusion-splicing step.

[0019] A post-fusion heating step is performed after the fusion-splicing step. In this step, the dopant is diffused by heating a portion including the fusion-spliced part 3 between the Optical Fiber 1 and 2. The MFD at the adjacent end face of the Optical Fiber 2, having been initially small, enlarges rapidly during the post-fusion heating step, becomes larger than that of the adjacent end face of the Optical Fiber 1, reaches peak after a period of time, and subsequently becomes smaller and closer to that of the adjacent end face of the Optical Fiber 1. The MFD at the adjacent end face of the Optical Fiber 2 is accordingly adjusted so as to reduce the difference between the MFDs at the fusion-spliced part 3 of the two fibers. Thus, the splicing loss gradually decreases as the MFD at the-adjacent-end-face of the Optical Fiber 2 decreases as time passes. The same heating source as in the pre-fusion heating step can be used as a heating source in the post-fusion heating step. The heating temperature for this process is determined such that the dopant having been added both optical fibers can be diffused, but neither of the optical fibers are softened.

[0020] Figure 6 shows an optical transmission line 6 comprising Optical Fiber 1 and 2 connected together in accordance with the method as described above. The fusion splicing loss of the fusion-spliced part 3 can be reduced to 0.2 dB or less. The optical transmission line 6 is provided between a transmitter 7 and a receiver 8.

[0021] The embodiment will now be described more in detail. A single mode optical fiber 21 having the refractive index profile shown in Fig. 2 is prepared here as the Optical Fiber 1. The optical fiber 21 comprises a core

region 22 having a high refractive index and including the optical axis, and a cladding region 23 having a low refractive index and surrounding the core region 22. Both regions together form a simple step index profile. The outer diameter of the core region 22 is 8.2 μm and the outer diameter of the cladding region 23, i.e., the outer diameter of the fiber is 125 μm. The relative refractive index difference of the core region 22 is 0.34% compared to that of the cladding region 23. At the wavelength of 1.55 μm, the optical fiber 21 has a chromatic dispersion of 17 ps/nm/km, a dispersion slope of 0.057 ps/nm^2/km, a MFD $2W_1$ of 10.7 μm defined by Petermann I, a MFD $2W_2$ of 10.3 μm defined by Petermann II, and an effective core area of 80 μm^2. The MFD $2W_2$ can be obtained by the following formula:

$$W_2^2 = \frac{2\int_0^\infty E^2(r)rdr}{\int_0^\infty (\frac{dE(r)}{dr})^2 rdr}$$

, where E (r) represents the distribution of the LP01 mode.

[0022] On the other hand, a dispersion compensating optical fiber 31 having the refractive index profile shown in Fig. 3 is prepared as the Optical Fiber 2. The optical fiber 31 comprises a core region 32 including the optical axis, a trench region 33 surrounding the core region 32, a ridge region 34 surrounding the trench region 33, and a cladding region 35 surrounding the ridge region 34, which together form the refractive index profile.

[0023] The outer diameters of the core region 32, the trench region 33, and the ridge region 34 are 4 μm, 10 μm, and 17 μm, respectively. The outer diameter of the cladding region 35, i.e., the outer diameter of the fiber, is 125 μm. The relative refractive index differences of the core region 32, the trench region 33, and the ridge region 34 are 1.6%, -0.5%, and 0.2%, respectively, compared to that of the cladding region 35. At the wavelength of 1.55 μm, the second optical fiber 31 has a chromatic dispersion of -96 ps/nm/km, a dispersion slope of -0.75 ps/nm^2/km, an MFD $2W_1$ of 7.7 μm defined by Petermann I, an MFD $2W_2$ of 4.9 μm defined by Petermann II, and an effective core area of 19 μm^2.

[0024] During the pre-fusion heating step in this embodiment, the MFD $2W_1$ at the adjacent end face of the optical fiber 21 is enlarged from 10.7 μm to 14.9 μm, the MFD $2W_2$ from 10.3 μm to 13.2 μm, and the effective core area from 80 μm^2 to 131 μm^2.

[0025] Figs. 4A and 4B show variation of MFDs defined by Petermann I at the adjacent end faces of the Optical fiber 1 and 2 and splicing loss, respectively as heating time passes as shown in the axis of abscissas during the post-fusion heating step.

[0026] As shown in Fig. 4A, the MFD at the adjacent end face of the Optical Fiber 1 varies little as time passes, substantially keeping the diameter as enlarged during the pre-fusion heating step. On the other hand, the MFD at the adjacent end face of Optical Fiber 2, initially having been smaller, becomes rapidly larger than that at the adjacent end face of the Optical Fiber 1, reaches a peak after a period of time, and subsequently becomes smaller and closer to that at the adjacent end face of the Optical Fiber 1. As shown in Fig. 4B, as the MFD at the adjacent end face of the Optical Fiber 2 varies as time passes, the splicing loss decreases from about 1.7 dB to about 0.08 dB after 450 seconds, and thereafter remaines as low as this value.

[0027] The embodiment as above-mentioned is the case preparing the post-fusion heating step after fusion-splicing step, however, if in fusion-splicing step dopant can be diffused sufficiently so that MFD of the two fibers may become close to each other, such post-fusion heating step does not necessarily needed.

[0028] Figures 5A and 5B show variation of the MFDs defined by Petermann I at the adjacent end faces of the Optical Fiber 1 and 2 and the splicing loss, respectively as heating time passes with the method of splicing two optical fibers similar to the above mentioned embodiment, but without the pre-fusion heating step as shown in the axis of abscissas during the post-fusion heating step.

[0029] As shown in Fig. 5A, the MFD at the adjacent end face of the Optical Fiber 1 varies little as time passes, substantially keeping the initial diameter. On the other hand, the MFD at the adjacent end face of the Optical Fiber 2, initially having been smaller, becomes rapidly larger than that at the adjacent end face of the Optical Fiber 1, reaches a peak after a period of time, and subsequently becomes smaller. The MFD at the adjacent end face of the Optical Fiber 2, however, does not decrease to approximately same MFD at the adjacent end face of the Optical Fiber 1, and the difference between MFD of the two fibers remains about 4 μm, unlike the case of the embodiment. As shown in Fig. 5B, as the MFD at the adjacent end face of the Optical Fiber 2 varies as time passes, the splicing loss decreases from about 1.3 dB to about 0.4 dB after 450 seconds, and thereafter, does not decrease any further.

[0030] When the fusion-splicing step has been performed after enlarging MFD at the adjacent end face of the Optical Fiber 2 whose MFD is smaller than that of Optical Fiber 1, as disclosed in Japanese Patent Application Laid Open No. 04-118607, the MFDs of the two optical fibers do not become close to each other, thus resulting in failure to reduce the splicing loss, similar to the case as shown in Fig. 5A and Fig. B.

Claims

1. A method of connecting a first optical fiber having a first MFD and a second optical fiber having a second MFD smaller than the first MFD, by fusion splicing method, comprising:

a step of heating a portion including an adjacent end face of the first optical fiber so as to diffuse a dopant: and

a step of connecting the first and the second optical fibers by fusion-splicing.

2. The method of connecting optical fibers by fusion splicing according to Claim 1, further comprising a step of heating a portion including the fusion-spliced part between the first and the second optical fibers so as to diffuse the dopant contained therein.

3. The method of connecting optical fibers by fusion splicing according to Claim 1, wherein the MFD defined by Petermann I at the adjacent end face of the first optical fiber is enlarged by at least 1 μm by heating the portion including the adjacent end face thereof so as to diffuse the dopant during the heating step before fusion splicing.

4. An optical transmission line, including a first optical fiber having a first MFD and a second optical fiber having a second MFD smaller than the first MFD, fabricated by a process comprising:

a step of heating a portion including an adjacent end face of the first optical fiber so as to diffuse a dopant; and

a step of connecting the first and the second optical fibers by fusion-splicing.

5. An optical transmission line, including a first optical fiber having a first MFD and a second optical fiber having a second MFD smaller than the first MFD, fabricated by a process comprising:

a step of heating a portion including an adjacent end face of the first optical fiber so as to diffuse a dopant;

a step of connecting the first and the second optical fibers by fusion-splicing; and

a step of heating a portion including the fusion-spliced part between the first and the second optical fibers so as to diffuse the dopant contained therein.

6. The optical transmission line according to Claim 4, wherein the MFD defined by Petermann I at the fusion spliced part of the first and the second optical fibers becomes at least 1 μm larger than those at the other parts thereof.

7. The optical transmission line according to Claim 5, wherein the MFD defined by Petermann I at the fusion-spliced part of the first and the second optical fibers becomes at least 1 μm larger than those at the other parts thereof.

FIG. 1

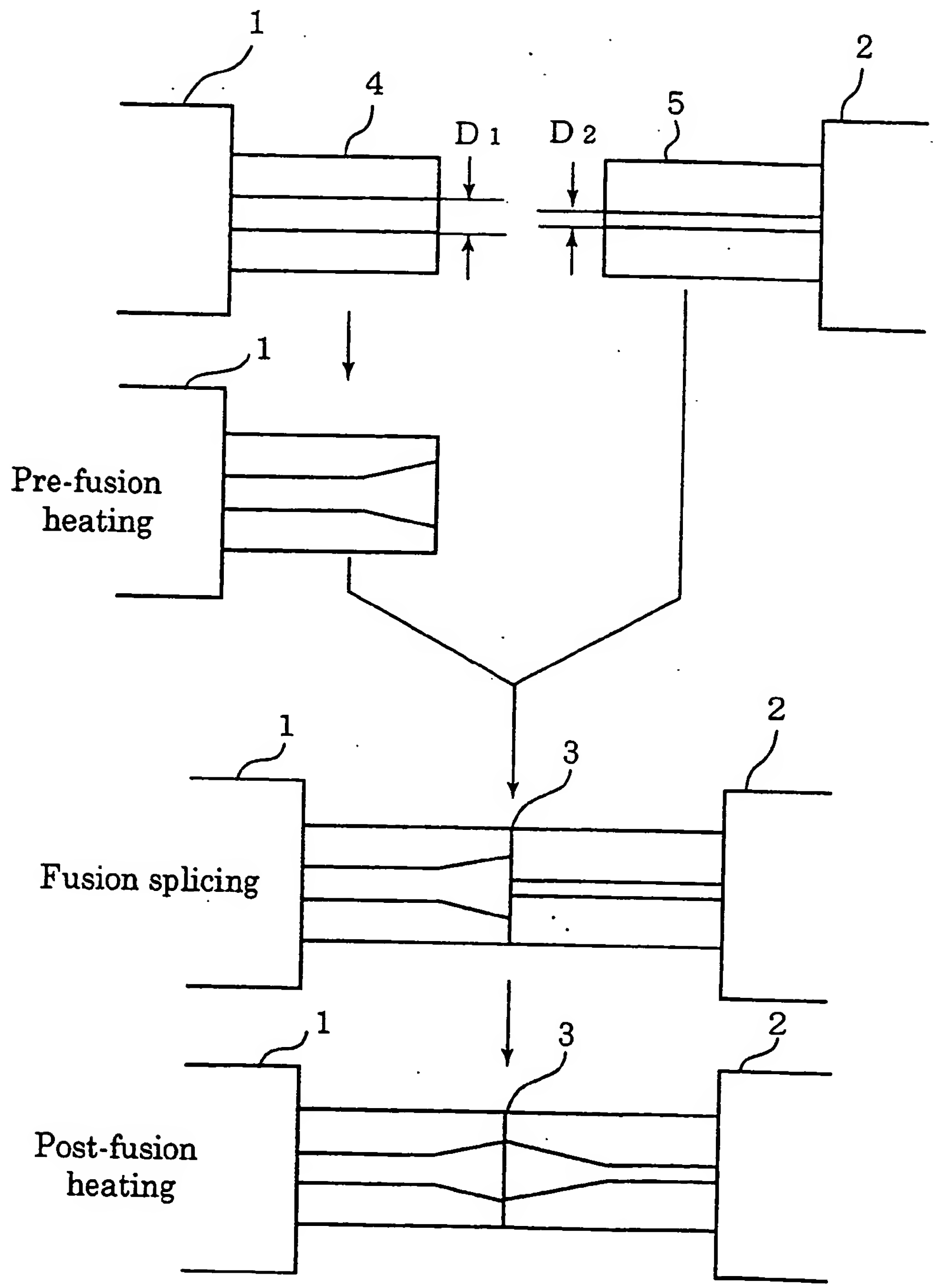

1
4
D 1
D 2
5
2
1
Pre-fusion heating
1
3
2
Fusion splicing
1
3
2
Post-fusion heating

FIG. 2

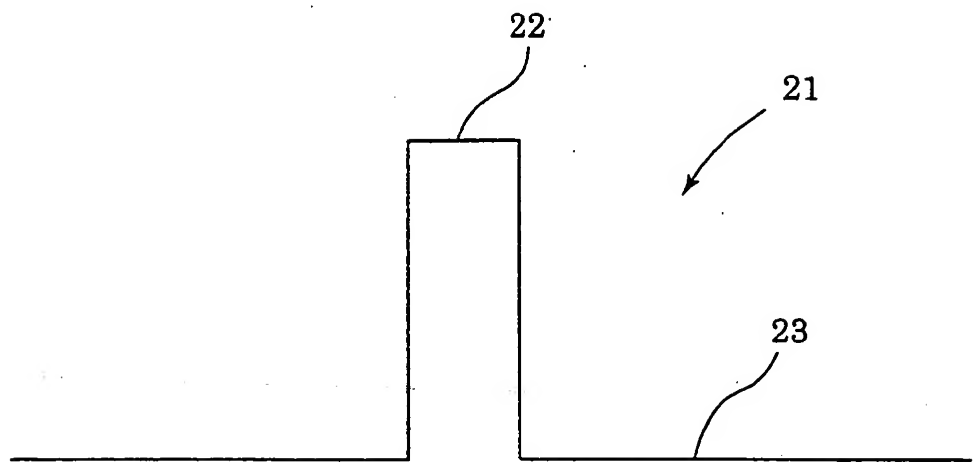


FIG. 3

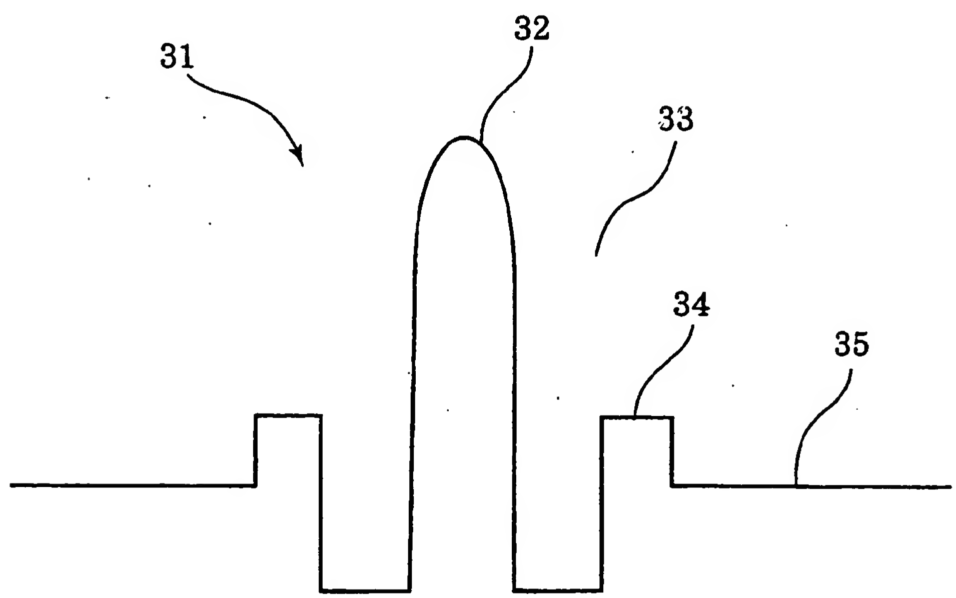


FIG. 4A

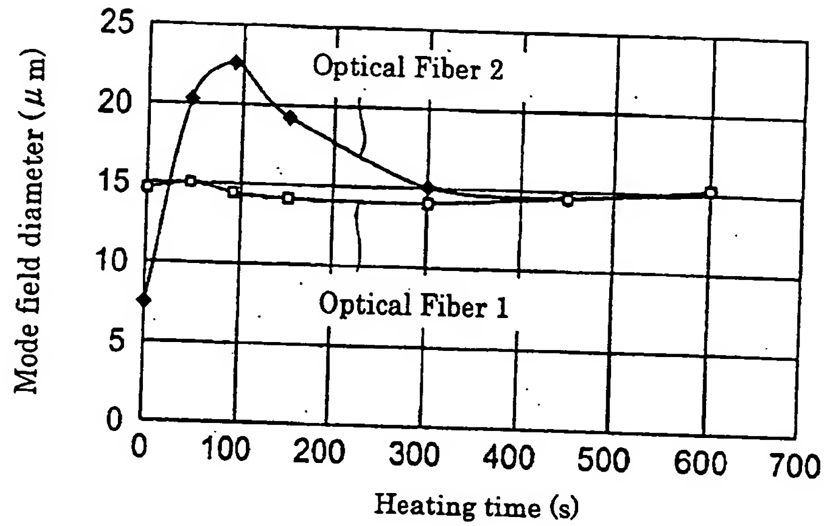

25
20
15
10
5
0
Mode field diameter (μ m)
Optical Fiber 2
Optical Fiber 1
0
100
200
300
400
500
600
700
Heating time (s)

FIG. 4B

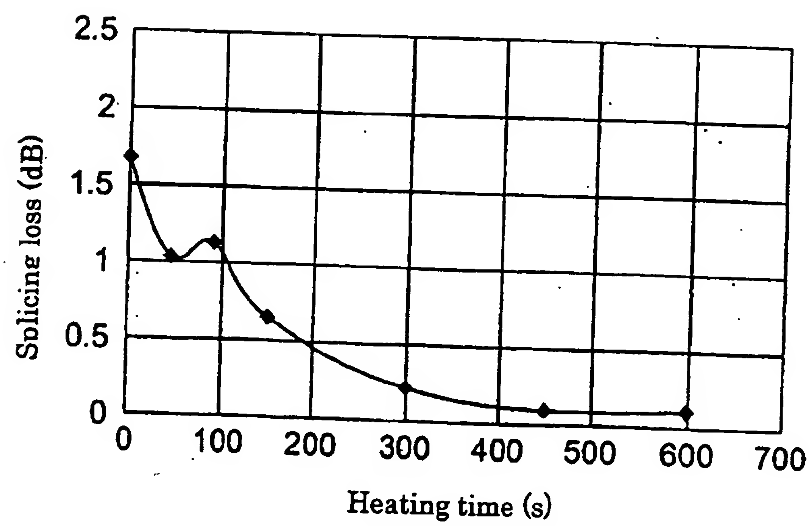
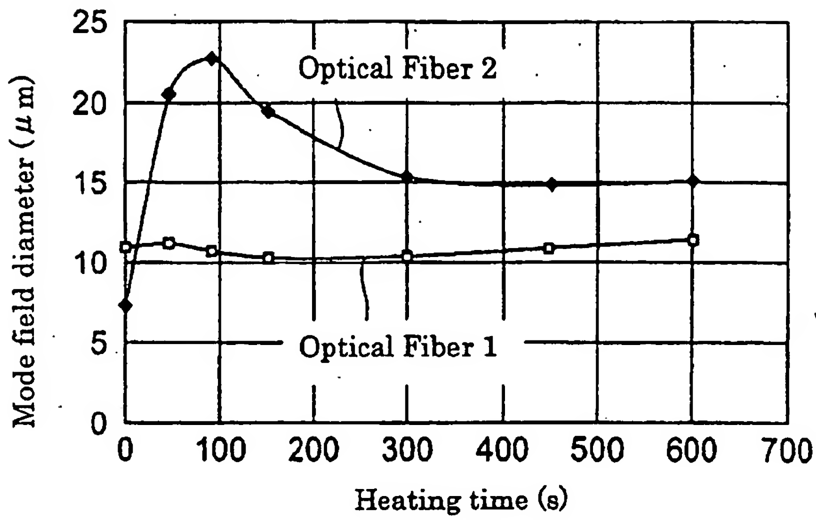
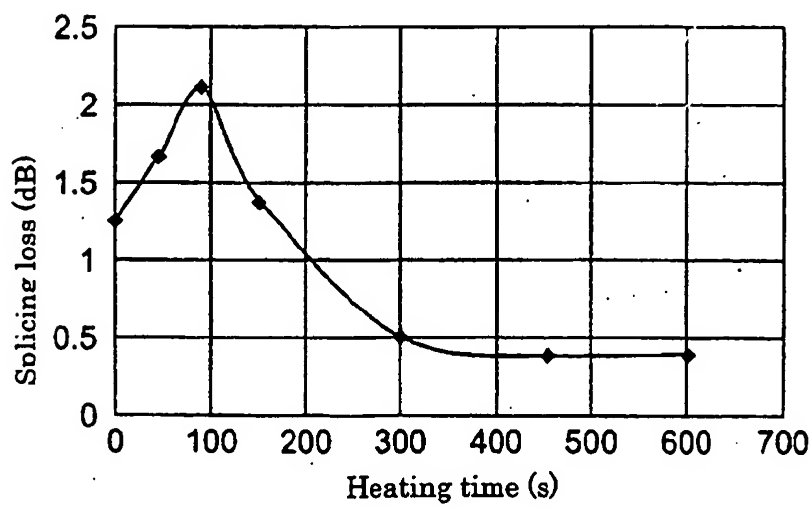

2.5
2
1.5
1
0.5
0
Splicing loss (dB)
0
100
200
300
400
500
600
700
Heating time (s)

FIG. 5A



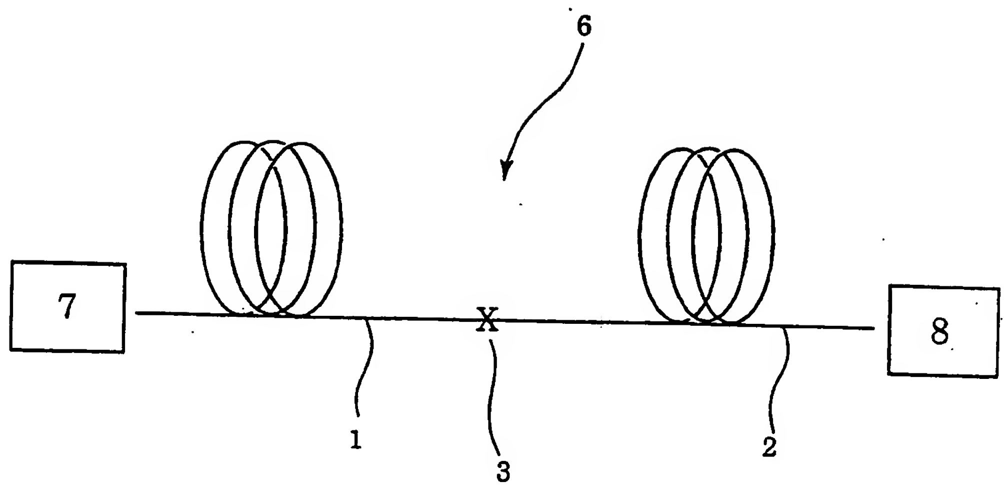
25
20
15
10
5
0
0
100
200
300
400
500
600
700
Mode field diameter (μm)
Heating time (s)
Optical Fiber 2
Optical Fiber 1

FIG. 5B



2.5
2
1.5
1
0.5
0
0
100
200
300
400
500
600
700
Splicing loss (dB)
Heating time (s)

FIG. 6



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 13 0239

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 1 063 544 A (SUMITOMO ELECTRIC INDUSTRIES) 27 December 2000 (2000-12-27) * column 2, line 46-48,54-56 * * column 3, line 1,2,6,7,27 * * column 4, line 33-36 * * column 5, line 7-11,21-24 * * column 6, line 50-56 * * figure 8 *	1,3,4,6	G02B6/255
Y		2,5,7	

Y	EP 0 340 042 A (BRITISH TELECOMM) 2 November 1989 (1989-11-02) * abstract * * column 2, line 11-21,62,63 * * column 3, line 52-54,56,57 * * figures 1,2 *	2,5,7	

A	EP 0 076 186 A (THOMSON CSF) 6 April 1983 (1983-04-06) * page 1, line 31,32 * * page 2, line 1-4 * * page 5, line 12-16 *	1-7	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
	---		G02B
A	US 4 954 152 A (HSU HUI-PIN ET AL) 4 September 1990 (1990-09-04) * column 2, line 24-37 * * column 9, line 3-16 * * column 10, line 5-10 *	1-7	

A,P	EP 1 154 296 A (SUMITOMO ELECTRIC INDUSTRIES) 14 November 2001 (2001-11-14) * column 1, line 25 * * column 2, line 45-51 * * column 6, line 10-14 *	1-7	

	-/--		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	9 April 2002	Fazio, V

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 13 0239

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	EP 0 749 025 A (SUMIDEN OPCOM LTD ;SUMITOMO ELECTRIC INDUSTRIES (JP)) 18 December 1996 (1996-12-18) * column 3, line 26,27 * * column 6, line 37,38,40-42,44,45,51-55 * * column 7, line 12,13 * ---	1-7	
E	EP 1 174 741 A (SUMITOMO ELECTRIC INDUSTRIES) 23 January 2002 (2002-01-23) * page 2, line 51,52 * * page 3, line 1-2,8-915-18,21-22,25-26 * * page 4, line 17,33,34 * * figures 1A,1B * -----	1-7	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	9 April 2002	Fazio, V

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
....
& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 13 0239

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

09-04-2002

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 1063544	A	27-12-2000	JP	2001004865	A	12-01-2001
			AU	4090200	A	04-01-2001
			EP	1063544	A2	27-12-2000
EP 0340042	A	02-11-1989	AT	82561	T	15-12-1992
			AU	629214	B2	01-10-1992
			AU	3571189	A	24-11-1989
			CA	1317803	A1	18-05-1993
			DE	68903528	D1	24-12-1992
			DE	68903528	T2	01-07-1993
			EP	0340042	A1	02-11-1989
			ES	2036029	T3	01-05-1993
			WO	8910332	A1	02-11-1989
			HK	129496	A	26-07-1996
			JP	2911932	B2	28-06-1999
			JP	3504052	T	05-09-1991
			US	5142603	A	25-08-1992
EP 0076186	A	06-04-1983	FR	2513394	A1	25-03-1983
			EP	0076186	A1	06-04-1983
			JP	58066905	A	21-04-1983
US 4954152	A	04-09-1990	AU	619618	B2	30-01-1992
			AU	4526389	A	10-07-1990
			CA	2002986	A1	19-06-1990
			DE	68908402	D1	16-09-1993
			DE	68908402	T2	02-12-1993
			EP	0401324	A1	12-12-1990
			ES	2020367	A6	01-08-1991
			JP	3502839	T	27-06-1991
			KR	9311821	B1	21-12-1993
			NO	903560	A	14-08-1990
			WO	9007134	A1	28-06-1990
EP 1154296	A	14-11-2001	JP	2001318262	A	16-11-2001
			AU	4372901	A	15-11-2001
			EP	1154296	A2	14-11-2001
			US	2001041037	A1	15-11-2001
EP 0749025	A	18-12-1996	JP	4368904	A	21-12-1992
			JP	5011133	A	19-01-1993
			EP	0749025	A1	18-12-1996
			AU	653605	B2	06-10-1994
			AU	1833192	A	24-12-1992
			CA	2071344	A1	19-12-1992
			DE	69223348	D1	15-01-1998

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 13 0239

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

09-04-2002

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 0749025	A		DE	69223348 T2	26-03-1998
			DE	69231103 D1	29-06-2000
			DE	69231103 T2	21-09-2000
			EP	0519440 A2	23-12-1992
			ES	2109958 T3	01-02-1998
			US	5309536 A	03-05-1994
EP 1174741	A	23-01-2002	AU	1055501 A	14-05-2001
			EP	1174741 A1	23-01-2002
			WO	0133266 A1	10-05-2001

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82